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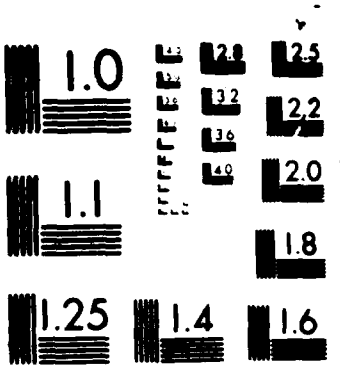

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This final report describes the usages of the VAX-11/780 and its peripheral equipment and software purchased under this URIP grant. A major emphasis has been on research on voice interactive natural language systems.

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FINAL REPORT
DOD EQUIPMENT GRANT AFOSR-84-0265

by

Alan W. Biermann

This letter is to report the usages of the Digital Equipment Corporation VAX-11/780 and its peripheral equipment and software as purchased with cost sharing under our 1984 Department of Defense University instrumentation grant.

The most important point to emphasize relates to the equipment situation in the department before the grant was made. Prior to the summer of 1984, our only departmental machine was a PDP-11/70 mini-computer which was shared for research by our dozen faculty members and forty to fifty graduate students. Furthermore, the PDP11/70 had begun to show its age by staging a series of major brakdowns during the 1983-84 year. All of our research projects suffered severe setbacks during that period. In the summer of 1984, we prepared our natural language processor for testing and hired an experimenter to do the work. However, the load on the machine was so great we were only able to run a few pilot tests and the primary testing was cancelled. As another example, we had been carrying on research on an expert system called the Graduate Course Advisor. Because of the inadequacy of our equipment, we moved the system to a VAX at the University of North Carolina and borrowed time in order to continue work.

In the summer of 1984, a new VAX-780 became operative which was funded by the National Science Foundation. Soon after, the new Department of Defense funded VAX-780 was installed. The first machine became the primary system for departmental use and the second became the "A.I." machine. Furthermore, two other smaller machines were installed in the department. Needless to say, the lid was thus taken on of our computing activities in artificial intelligence and a dozen or more projects went into high gear. All of these projects are under my direction and/or Dr. Donald Loveland's direction. They are funded by the Army Research Office, the Air Force Office of Scientific Research, and the National Science Foundation.

A major emphasis has been in research on voice interactive natural language systems. We have developed an office oriented interactive system which enables users to display text on a screen and manipulate it with voice and touch commands. During the past eight months, we have been optimizing this system for fast response so that it can run in real time. In fact, with the help of this new machine, it has been possible to reduce turnaround time from about 15 seconds to about 2 seconds.

This means that users can now sit down to the machine and talk to it at conversational speeds, about six sentences per minute, and see the requested actions carried out. We are now beginning human factors studies to determine how well people are able to function in using the system. And, of course, we will build a list of system shortcomings which will give direction to our future work. It is safe to say none of this experimental work, which requires CPU intensive computations in real time, would be possible without the new machine. (Personnel: Linda Fineman, K.C. Gilbert, Robert Rodman.)

Simultaneously, we have developed for the Army Electro-Optics and Night Vision Laboratory, Ft. Belvoir, a simulator for a voice and touch interactive target tracker and fire control system. This system demonstrates in real time how such a system would operate in a helicopter environment. The pilot is able to track targets, query the system concerning their identity and range, and launch missiles using spoken English commands. Again the importance of large real time CPU resources is clear for this project. (Personnel: K.C. Gilbert, Fran Heidlage.)

In two other projects in natural language processing, we are developing a model for high level cognitive processing in dialogue systems (Barry Koster) and we are making beginning steps toward constructing our own voice recognizer (Elizabeth Edmiston, Nathan Hillary). This latter effort uses the speech systems development kit from Signal Technology Corporation which was funded by the equipment grant and would not have been possible without it.

We have been carrying out a series of studies on learning systems. One study (Amr Fahmy) examines the problem faced by an industrial programmer who may not know which of several different algorithms to apply in a particular situation. The correct choice of algorithm depends on the instrinsic characteristics of the various alternatives, on the nature of the data to be handled in the application, on the machine, and many other factors. Our solution to the problem is to install all of the alternative algorithms into the application along with a monitor to automatically measure their performance. Each time the application requires the given calculation, the monitor chooses one of the alternative programs, runs it to solve the problem, and registers its execution time. Over a period of time, the monitor "learns" which algorithm to use and when, and it uses this information to obtain optimum behavior. It may eventually self destruct, leaving behind a more efficient implementation than would have been possible otherwise.

A second study in learning (Albert Nigrin, Marco Valtorta), examines the problem of finding acceptable confidence factors for production rules in expert systems. Currently, experts estimate their confidence in particular rules for decision making systems, and these estimates are combined by the machine to evaluate alternatives and to select a best decision. Unfortunately, the complexities of the apparatus sometimes give surprising and undesirable actions because of the ways in which these confidence factors are used. This study seeks to infer the correct values for confidence factors from examples of terminal behavior. When the confidence factors are derived from known cases of correct behavior, their validity is guaranteed and the chances of unpredicted system actions are reduced or eliminated.

Finally, we are conducting a series of comparative tests of learning systems to try to understand their error behavior (K.C. Gilbert). While numerous learning machines have been studied in the literature, little data is available to indicate which systems may be more desirable. We are developing a series of tools for the experimental exploration of about eight different learning systems to gain insights into their general characteristics. All of these studies in learning involve extensive simulations on our new DOD funded computer.

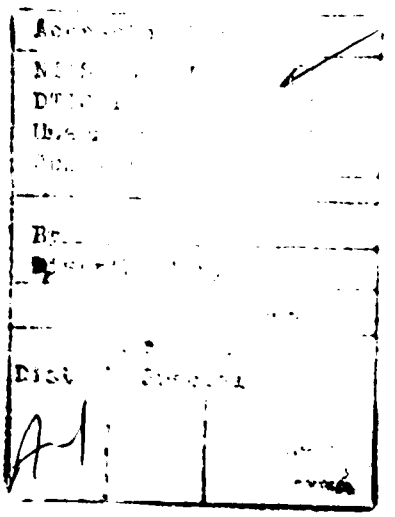
With computing facilities re-established in our department, our Graduate Course Advisor expert system project was moved back from UNC and has continued in its development (Donald Loveland, Marco Valtorta, Bruce Smith, Doug Petry). Emphasis in this project has been on issues related to handling a large amount of knowledge, reliable deduction, and a good human-machine interface.

Another project is concerned with the discovery of good test procedures to isolate and treat faults (or diseases) that are causing an observed failure in a system behavior. Sometimes treatment for the fault can be given before its precise nature is known, thereby reducing the diagnosis cost (Donald Loveland, Paul Lanzkron).

Finally, we have a project which examines decision mechanisms under the constraint that only limited search is possible. Thus the question arises as to where to invest resources in a search algorithm to maximally increase the choices of a correct decision (D. Mutchler).

This list is not exhaustive but gives a reasonable view of usages of the DOD sponsored equipment purchases. In late 1985, we received another grant from Digital Equipment Corporation for $244,323 and with additional Duke University funds were able to upgrade this machine to a VAX8600. Thus the original DOD grant seeded equipment acquisitions which now amount to over three times the original award. We have moved from a severely hobbled Artificial Intelligence program to a well equipped and thriving enterprise. All of the above projects are further described in numerous published articles and recent manuscripts which can be provided if needed.

A listing of the equipment purchases follows:



Equipment Purchases from DoD Grant AFOSR-84-0265		
Apple Computer	Macintosh 512K, Imagewriter II and	
	Accessory Kit (2)	$4,150.00
Digital Equipment	Dectalk DTC01-A	$3,086.23
Digital Equipment	Unibus Adaptor 11/780 120V,	
	456MB 16B Disk 120V/60	$28,256.72
Digital Equipment	Flt Pt Proc 11/780 120V, 11/780 Single Acc Tape Sys,	
	VAX 11 Fortran Lic W/Warr, UBUS to Ethernet Controller	$230,549.26
Digital Equipment	11/780 Special Upgrade Kit	$42,679.57
Microglyphics	Imagen 8/300 Laser Printer for use	
	with VAX780	$19,109.52
Quintus	Quintus prolog release 1.0 for VAX 8600	$8,900.00
Signal Technology	ILS and DACS Software Distribution Kits	
	for UNIX and VMS	$8,823.00
Vectrix	19 inch monitor with cards	$7,365.70

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